BP1: COMPUTATIONAL ELECTROMAGNETICS; Finite Element Methods

Adaptive Mesh Refinement for Microelectronic Device Design

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Finite element and finite volume methods are used in a variety of design simulations when it is necessary to compute fields throughout regions that contain varying materials or geometry. Convergence of the simulation can be assessed by uniformly increasing the mesh density until an observable quantity stabilizes. Depending on the electrical size of the problem, uniform refinement of the mesh may be computationally infeasible due to memory limitations. Similarly, depending on the geometric complexity of the object being modeled, uniform refinement can be inefficient since regions that do not need refinement add to the computational expense. In either case, convergence to the correct (measured) solution is not guaranteed.

Adaptive mesh refinement methods attempt to selectively refine the region of the mesh that is estimated to contain proportionally higher solution errors. The refinement may be obtained by decreasing the element size (h-refinement), by increasing the order of the element (p-refinement) or by a combination of the two (h-p refinement). A successful adaptive strategy refines the mesh to produce an accurate solution measured against the correct fields without undue computational expense. This is accomplished by the use of a) reliable *a posteriori* error estimates, b) hierarchal elements, and c) automatic adaptive mesh generation.

Adaptive methods are also useful when problems with multi-scale field variations are encountered. These occur in active electronic devices that have thin doped layers and also when mixed physics is used in the calculation. The mesh needs to be fine at and near the thin layer to capture rapid field or charge variations, but can coarsen away from these layers where field variations smoothen and charge densities are uniform.

This poster will present an adaptive mesh refinement package that runs on parallel computers and is applied to specific microelectronic device simulations. Passive sensors that operate in the infrared portion of the spectrum as well as active device simulations that model charge transport and Maxwell's equations will be presented.

The work described in this publication was carried out by the Jet Propulsion Laboratory, California Institute of Technology under a contract with the National Aeronautics and Space Administration. The supercomputer used in this investigation was provided by funding from the NASA Offices of Earth Science, Aeronautics, and Space Science.